Microbial Biological Control Symposium
Abstract: “Physiological vs. ecological host range.”
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The mantra in biological control by microbial agents is safety. Host specific organisms are safe to use as biological control agents. Although host specific organisms are known for many targets, candidate agents must be tested to clearly understand and confirm this as a property of the organism under evaluation. In nature, organisms contend with physical and environmental limitations that are important in defining the natural, or “Ecological”, host range. During evaluation of candidate organisms, host specificity tests, i.e., host range determinations (HRD), are conducted under artificial, optimal conditions that favor the biological control candidate, usually in a laboratory or greenhouse setting. In these situations, many factors are removed from the interaction that otherwise limit infection or attack in nature, thus resulting in an extreme test of a candidate organism for potential to affect species other than those it attacks in nature. In addition to optimal environmental conditions, HRD often includes exposure of target and non-target species at a vulnerable stage of growth either to unnaturally high concentrations of the biological control agent, delivery of the agent to the point of attack on the pest, or to other unnatural conditions, such as “no-choice” behavioral studies.

In many cases, the list of non-target species that are “attacked” under artificial test conditions is larger than that recorded in nature, and this is known as the “Physiological” host range. Results of artificial HRD must be interpreted on the basis of field expectations. If under optimal test conditions, an agent does not attack non-target test species, it is considered safe to use for pest control, provided the test plant list is properly constructed and representative. If under optimal test conditions, a non-target species of ecologic or economic importance is clearly damaged by the candidate, then the agent is dropped from evaluation for biological control. If, however, limited or non-damaging activity is recorded by a candidate on a non-target species under optimal, artificial conditions, unique challenges arise concerning both the proper completion of a risk assessment by scientists and the communication of results about safety to regulators. When exotic (foreign) organisms are evaluated, the HRD may result in identifying potentially new associations, a possibility for non-target species that have not evolved with the candidate agent. Would these be considered part of the ecological or the physiological host range if discovery resulted from artificial test conditions of the HRD?

This is not a new problem, nor is the solution simple. In the interest of properly determining host range and risk of a candidate agent, and in the interest of providing regulators with the best information upon which to make decisions about releases, scientists have published dozens of papers since the 1960s. Among the topics are the construction of a proper host range test list and the analysis and interpretation of data. Recent publications on this subject are evidence that the struggle persists. Every solution proposed has other limitations. For example, field studies in

the native range of the target pest have been recommended. Although this has merit, one important concern relates to inclusion of native North American species in tests overseas. Also proposed are detailed investigations about physiological factors that delimit host range, but such studies are complicated, expensive, and long-term.

Success was achieved at the FDWSRU on two occasions by treating the host range determination as “Phase 1”, out of two possible steps. The HRD is used both to eliminate non-susceptible species and to identify those with visible reactions resulting from inoculation, the latter then identified as potentially hazardous. Judgment is made about whether or not damage occurs on the non-target plant. If the infection is considered minor or incidence is low compared to target species reaction, then detailed quantitative studies are made concerning the response of the non-target species to inoculation. Simply determining if the pathogen can be maintained on the non-target species, or if there measurable effect on plant dry weight or other yield variables, provides considerable insight into the amount of effect. It remains a challenge to relate greenhouse responses to expectations in the field. In some cases, it is possible to conduct side-by-side comparisons with related pathogens in the field. In the case of musk thistle rust (*Puccinia carduorum*), which caused very limited infection of artichokes in the greenhouse, an isolate of *P. carduorum* from *Carduus tenuiflorus* growing near uninfected artichokes in California was found to capable of infecting artichokes under greenhouse conditions. Yellow starthistle rust (*P. jaceae* var. *solstitialis*) infected safflower in greenhouse tests, but infections were significantly less than those cause by a California isolate of safflower rust (*P. carthami*) in side-by-side comparisons. Safflower rust is manageable during crop production, and measures for control of *P. carthami* also would control *P. jaceae*. In each of these cases, greenhouse data could be connected to field scenarios, thus facilitating judgments about safety.

The process of sorting out physiological vs. ecological host ranges is improving. Now there are powerful new tools at the disposal of most scientists. This includes molecular information about both candidate agents and target relatives that was not available 35 years ago. Also, there are computers and powerful statistical software that facilitates manipulation and testing of data about relationships and non-target species responses.